Impact to Ground Water Standards

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Purpose of the Impact to Ground Water Standards

- Protection of ground water from future contamination by chemicals leaching from the soil
- Protection of human health from contaminated ground water ingestion

Why change from the 1992 Soil Cleanup Criteria methodology?

1992 SCC Methodology

- Semi-volatiles - ranking system
- Volatile organics - Jury model
- Inorganics - develop on site specific basis

Proposed IGW Standards

- Tiered Approach for Standards
  - Generic - for cases/sites with little or no site specific information
  - Alternative Remediation Standards- (IGW ARS) - for cases/sites with some site information

Generic Impact to Ground Water Soil Remediation Standards

<u>Generic standards</u> - based on conservative simple partitioning equation in order to apply state-wide without site specific information.

Generic IGW Soil Remediation Standards Methodology

- 1996 USEPA Soil Screening Level Guidance Document

- Simple Partitioning Equation

- This equation was used to develop the generic Impact to Ground Water Soil Remediation Standards

USEPA Simple Partitioning Equation

- IGWSRS is calculated using the health based GWQC and a dilution attenuation factor
- Receptor well at downgradient edge of AOC. This results in ground water directly under an AOC meeting the GWQC.
- Contaminants in contact with ground water. This results in protection of ground water where there is no buffer zone between the contaminated soil and ground water.

Advantages of Simple Partitioning Equation

- Recommended by USEPA
- Consistent with several other states
- Scientifically defensible
- Protective of ground water users in most cases with little or no site specific information
- Protective of sites with contamination in most mobile form and extending to the water table

Alternative Remediation Standards (ARS)

Brownfields Act authorizes the use of of Alternative Remediation Standards based on site specific information

ARS Option A.
Site Specific Adjustment to the Simple Partitioning Equation

- Modification of key parameter values based on site specific data.
- Useful for
  - metals, where pH varies from default assumptions
  - semi-volatiles, where soil organic carbon content is elevated
  - higher dilution attenuation factor possible based on site specific ground water flow data.

ARS Option B. Immobile Chemicals

- Vadose zone contaminant transport model was used to predict which contaminants would migrate less than 1 foot in 100 years.
- Where a 2 foot clean zone exists between such a contaminant and the ground water, no further remediation is necessary.
- Most useful for:
  - some semi-volatiles,
  - some pesticides,
  - PCBs
  - lead

ARS Option C.
Synthetic Precipitation Leaching Procedure (SPLP)

- Uses USEPA Method 1312 to determine the concentration of a contaminant that will leach from the soil.

- Information from this test may be used to derive a site specific IGW ARS

ARS Option C.
Advantages of SPLP

- Uses on-site soil - leaching results are site/AOC specific
- Speciation of metals is a non-issue
- Can be used easily and in early stages of case processing
- Most commonly used and useful for metals, semi-volatiles and pesticides

ARS Option D.
SESOIL Modeling

- Used to predict migration of contamination through the vadose zone and the concentration at the water table using site specific data

- This option does not allow future ground water contamination above the GWQC

- Most useful for metals, semi-volatiles, and immobile chemicals if a clean zone exists

ARS Option E. Sesoil/AT123D
(Vadose Zone and GW Modeling)

- Data from the SESOIL model is used as source input to ground water transport model (AT123D) to back calculate an acceptable IGW ARS

- Ground water is contaminated and contamination shows a decreasing trend in accordance with Tech Regs for natural GW remediation

- Most useful for volatile organic compounds

ARS Option F. Consideration of Observed Ground Water Conditions

Metals, semi-volatiles and volatiles:

- Highest levels of contaminants at water table, yet no ground water impacts observed, no remediation needed

Applicability and Compliance

- Class IIA aquifers
- Single point compliance
- Monitored Natural Attenuation of Soils

  Where PHC related contaminants exist above generic levels, and remediation is impracticable, monitor ground water to demonstrate decreasing trends in ground water contamination

Questions?

SCC Semi-Volatile Compounds

- Used Ranking System
- Based on Solubility, Biodegradability and Toxicity for each chemical
- Cleanup Criteria selected based on the sum of the Ranking

SCC Semi-Volatiles Disadvantages

- May not protect ground water users
- Has no backing from other agencies (ex. USEPA) or scientists
- Not consistent with method used for other compounds

TABLE 1. CATEGORIES OF PARAMETERS USED IN RANKING SYSTEM

CRITERIA	RANKING CATEGORY
Solubility (mg/1)	
<1.OE-2	4
1.0E-2 to 1.0E+2	8
>1.0E+2	12
Biodegradation	
Relatively Undegradable	3
Moderately Degradable	2
Significantly Degradable	1
Toxicity	
A) Carcinogens	
Cancer Slope Factor (mg/kg/day)-1	
<l.0E-1	1
1.0E-1 to 1.0E + 0	2
>1.0E+0	3
B) Noncarcinogens	
Oral RfD (mg/kg/day)	
<1E-4	3
1E-4 to lE-l	2
>1E-1	1

Total Ranking Sum	**Soil Standard (mg/kg)**
6-9	500
10-12	100
13-14	50
15-16	10
18	1

Example: Naphthalene

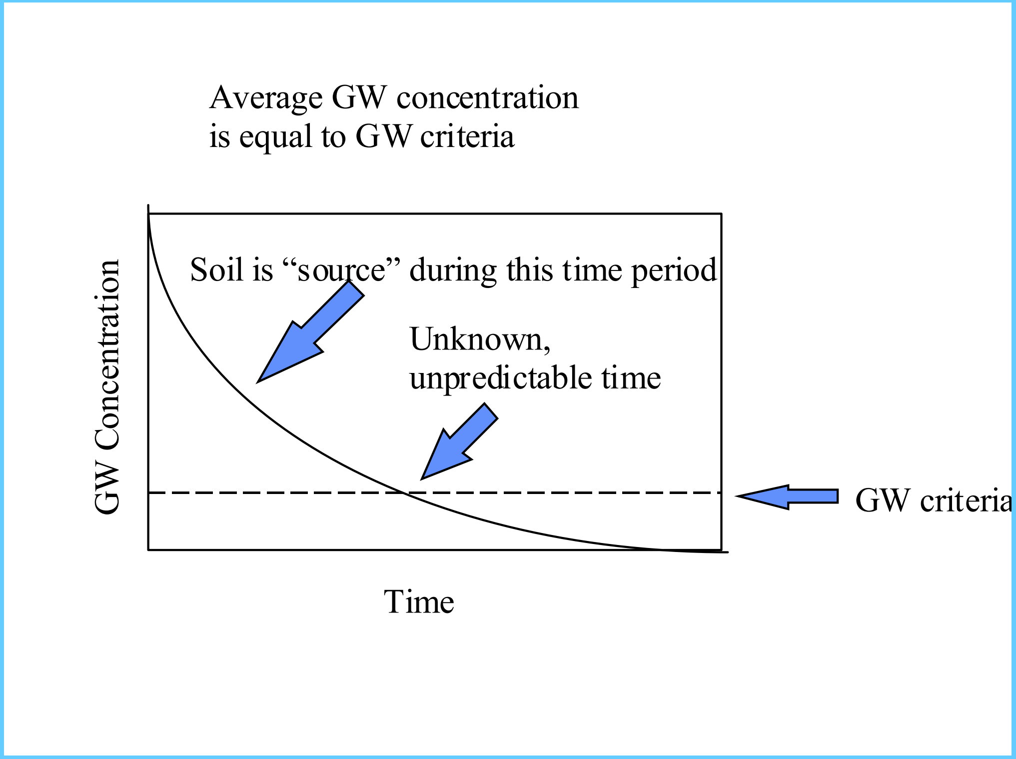
- Solubility = 8
- Biodegradation = 1
- Toxicity = 2
- Sum of Ranks = 11
- IGW SCC= 100 mg/kg

SCC Volatile Organic Compounds

- Jury Model
- The average concentration in ground water met the GWQS over a period 70 years
- A 6 foot thick clean zone was assumed

SCC Volatile Organics Disadvantages

- Not protective of GW users during initial time period
- Not protective of sites with clean zone less than 6 feet thick
- All criteria below 1 ppm were "rounded" to 1 ppm (benzene 0.3 ppm ▸ 1 ppm)



SCC Inorganic Contaminants

- No criteria were developed
- Footnote states that site specific criteria can be developed

USEPA Simple Partitioning Equation

- Organic Contaminants

$$IGWSCC = C_{gw}\left\{(K_{oc}f_{oc}) + \frac{\theta_w + \theta_a H'}{\rho_b}\right\}DAF$$

- Inorganic Contaminants

$$IGWSCC = C_{gw}\left\{(K_d) + \frac{\theta_w + \theta_a H'}{\rho_b}\right\}DAF$$

USEPA Simple Partitioning Assumptions

- receptor well at downgradient edge of AOC
- contaminants in contact with ground water
- contaminants uniformly distributed in AOC
- contaminants extend from surface to water table
- no degradation in AOC

Immobile Chemicals

- Aluminum
- Copper
- Lead
- Vanadium
- Aldrin
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(ghi)perylene
- Benzo(k)fluoranthene
- Bis(2-ethylhexyl phthalate)
- Butyl benzyl phthalate
- di-n-butyl phthalate
- Chlordane
- Chrysene
- DDD
- DDE
- DDT
- Dibenz(a,h)anthracene
- di-n-octyl phthalate
- Fluoranthene
- Heptachlor
- Heptachlor epoxide
- Hexachlorobenzene
- Hexachloro-1,3-butadiene
- Hexachlorocyclopentadiene
- Indeno(1,2,3-cd)pyrene
- Methoxychlor
- PCBs
- Pyrene
- Toxaphene

C. Synthetic Precipitation Leaching Procedure (SPLP)

- Uses USEPA Method 1312 to determine the concentration of a contaminant that will leach from the soil. This leachate concentration is compared to total soil concentration
  - Soil sample is split into two. First sample is analyzed for total contaminant concentration.
  - Remaining sample is subjected to leaching/extraction by liquid with a pH equivalent to acid rain, pH 4.2.
  - Contaminant concentration in leachate is compared to TGWC (GWQC*DAF)
- Results from SPLP test can be used directly by comparing leachate to target ground water concentrations (GWQC * DAF)
- Results may be used to determine site specific K_d which can be used to calculate a site specific IGWARS

Vadose Zone Modeling
(SESOIL)

- Vadose Zone Contaminant Transport Model
- Predicts movement of contaminants in soil prior to their reaching the ground water
- accounts for the contaminant migration processes of advection, volatilization, and degradation
- Precipitation is generated using a statistical formula that incorporates monthly New Jersey climate data.
- The model includes runoff, infiltration, evapotranspiration, and ground water recharge.
- Contaminant transport downward is calculated via advection using a retardation factor.
- Vapor phase transport is also modeled (upward direction only) to allow calculation of contaminant volatilization.

Vadose Zone and GW Modeling

Sesoil/AT123D

- Data from the SESOIL model is used as source input to ground water flow model
- AT123D is an analytical ground water contaminant transport model.
- It accounts for 1) advection 2) dispersion 3) adsorption 4) contaminant decay

Prerequisites for using SESOIL/AT123D Modeling

- ground water is already contaminated
- ground water concentrations at the source will meet GWQS within 5 years
- Source remediation to the calculated ARS will result in a decreasing trend in GW contaminant concentrations
- ground water contamination caused by the IGWARS will not extend beyond the actual ground water plume (which has to be fully delineated)